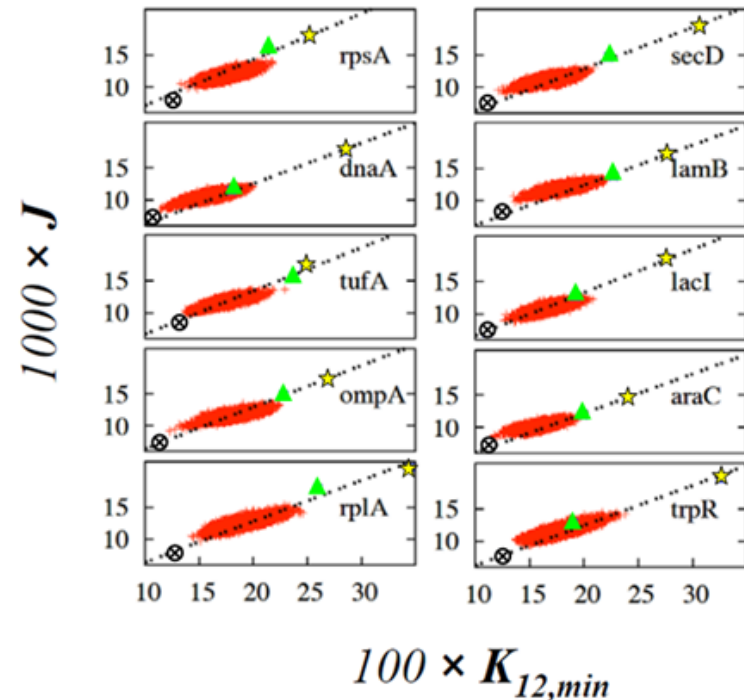


Statistical Mechanics of Systems far from Equilibrium

Beate Schmittmann and Royce K.P. Zia

Virginia Tech DMR-0705152/1005417

All living organisms require proteins to function properly. Each protein is a chain of up to $\sim 30,000$ amino acids (aa). Since there are only 20 different aa's, a protein is much like a 30K-letter “word,” made from 20 characters. Each “word” is synthesized from DNA, via a string of codons. Yet, there are 61 such codons, and so each aa is coded by up to 6 codons. Thus, there are many different codon strings which synthesize the same protein. Further, the rate of translation (from codon to aa) can be different for each codon – so we speak of “fast/slow” codons. Hence, the overall rate of production of a particular protein is highest/lowest if we choose the string with only fast/slow codons. The rate for the native sequence lies somewhere in between, of course. We ask: How does this rate compare to that of any of the other strings? Using a much-exploited model, we tested the rates for 10 proteins in *E.coli* and found that the native sequence outperforms 5000 randomly selected ones by as much as 6 sigma! In the figure, the ordinate (J) is the production rate, with the fastest/slowest/native cases denoted by $\star/\otimes/\blacktriangle$. Each red cluster contains 5000 points, corresponding to the random sequences.



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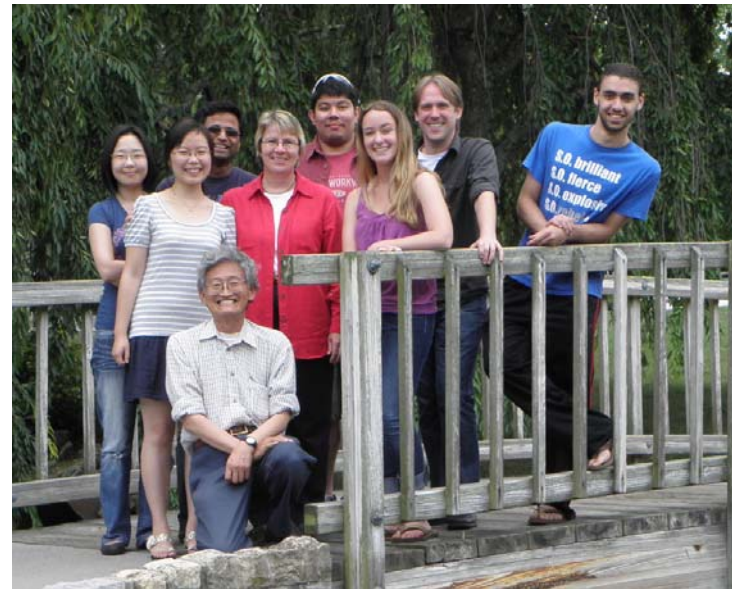
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Education and outreach:

We are committed to educating students and mentoring junior scientists, from Freshmen to postdocs and young alumni in academics and industries. Members of our group present their work regularly at conferences, workshops and colloquia. We publish (invited) “tutorials” and reviews on the statistical physics of protein synthesis. Beyond scientific outreach, the PI has also launched a comprehensive program for physics teacher education, under the national PhysTEC umbrella. Further afield, both of us regularly reach out to the general public, giving lectures on, e.g., “*Traffic, Genes, and Stocks: New Questions in Non-Equilibrium Statistical Physics*” and “*What is Physics? – a personal perspective.*” Well attended, these talks enjoyed considerable positive feedback.



From left: Hyunju Kim (postdoc), Wenjia Liu (PhD), Shivakumar Jolad (postdoc), Beate Schmittmann, Ben Intoy (PhD), Sara Case (Senior), Nick Borgers (PhD), and Ahmed Roman (Junior), **Kneeling:** Royce Zia. **Not in photo:** Clinton Durney (now at Ohio State).